

TITLE OF THE INVENTION

ACTUATOR LATCH DEVICE OF HARD DISK DRIVE

CLAIM OF PRIORITY

[0001] This application makes reference to, incorporates the same herein, and claims all benefits accruing under 35 U.S.C §119 from an application entitled *Actuator Latch Apparatus For Hard Disk Drive* earlier filed in the Korean Industrial Property Office on 17 February 2001, and there duly assigned Serial No. 2001-7994 by that Office.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] The present invention relates to an actuator latch device of a hard disk drive for locking a magnetic head in a parking area in a magnetic head transfer mechanism of a hard disk drive.

Description of the Related Art

[0003] A latching mechanism or locking device is typically utilized to prevent undesired movement of the actuator and thus protect the disk from the effects of mechanical shock to the drive. For example, a known magnetic latching mechanism is described in U.S. Patent No. 5,583,724 to Sung-Wook Kim et al. entitled *Magnetic Latching Apparatus For An Actuator Of A Hard Disk Drive*. A system using both mechanical and magnetic latching means is described in U.S. Patent No. 6,088,193 to Nigel F. Misso entitled *Pawl Latch For A Disc Drive*.

[0004] A hard disk drive similar to the 5,583,724 patent is shown in FIG. 1, and includes a hard

1 disk 20, rotatably installed on a base 10, where a predetermined information is recorded, and a
2 magnetic head transfer mechanism for transferring a magnetic head 50 to a desired track on the hard
3 disk 20 to record or reproduce information. Here, the hard disk is divided into a recording area 22
4 where information is recorded, and a parking area 21 provided inside the hard disk 20 where the
5 magnetic head 50 safely lands when the rotation of the hard disk 20 stops.

6 **[0005]** The magnetic head transfer mechanism includes an actuator 30 installed to be capable of
7 pivoting around a pivot shaft 34 provided on the base 10, where the magnetic head 50 is installed,
8 a voice coil motor for pivoting the actuator 30 by means of an electromagnetic force, and a latch
9 device for locking the actuator 30 after the magnetic head 50 safely lands on the parking area 21.

10 **[0006]** The actuator 30 includes a suspension portion 31 for supporting the magnetic head 50, a
11 arm 32 coupled to the pivot shaft 34 to be capable of pivoting, and a bobbin portion 33 around which
12 a mobile coil 35 of the voice coil motor is wound. The voice coil motor includes the mobile coil 35
13 wound around the bobbin portion 33, and a magnet 41 attached to a yoke 40 installed on the base
14 10 for generating a magnetic field. Although not shown in the drawing, a pair of yokes 40 are
15 arranged to face each other from upper and lower sides with respect to the actuator 30. An
16 electromagnetic force is generated by the interaction between the magnetic field generated by the
17 magnet 41 and current flowing through the mobile coil 35. Thus, the actuator 30 pivots in a
18 direction according to the Fleming's left hand rule.

19 **[0007]** Next, the latch device locks the actuator 30 to prevent movement after the magnetic head
20 50 safely lands on the parking area 21. The latch device includes a magnetic member 43 installed
21 at the yoke 40 and magnetized by the magnet 41, a damper 60 inserted in a coupling protrusion 36
22 provided at one end of the bobbin portion 33 of the actuator 30, and an iron piece 61 coupled to one
23 end portion of the damper 60. Thus, when the actuator 30 pivots and the magnetic head 50 installed

1 at the suspension portion 31 moves in the parking area 21 of the hard disk 20, as shown in the
2 drawing, the iron piece 61 coupled to the bobbin portion 33 adheres to the magnetic member 43.
3 Thus, until an electromagnetic force is generated to pivot the actuator 30, the actuator 30 remains
4 in a locked state in which the iron piece 61 and the magnetic member 43 are coupled together by the
5 magnetic force.

6 **[0008]** The reasons for locking the actuator 30 are as follows. First, the suspension portion 31 for
7 supporting the magnetic head 50 provides an elastic force in a direction in which the magnetic head
8 50 closely contacts a horizontal surface of the hard disk 20. Accordingly, unless an external force
9 is applied, the magnetic head 50 maintains a state of being in close contact with the horizontal
10 surface of the hard disk 20. However, as the hard disk 20 begins to rotate, flow of air around the
11 magnetic head 50 is generated by the rotation of the hard disk 20. The flow of air generates lift to
12 raise the magnetic head 50 from the horizontal surface of the hard disk 20. Thus, during recording
13 or reproducing information on or from the recording area 22 of the hard disk 20 which is rotating,
14 the magnetic head 50 is raised a predetermined flying height above the horizontal surface of the hard
15 disk 20 in a non-contact state. As long as the magnetic head 50 remains above the surface of the disk
16 20 scratches are prevented.

17 **[0009]** However, when the rotation of the hard disk 20 is completely stopped, for example, when
18 the power is turned off, the lift that has raised the magnetic head 50 gradually disappears as the
19 rotation speed of the hard disk 20 decreases and the actuator 30 pivots so that the magnetic head 50
20 is placed in the parking area 21 before the magnetic head 50 descends and collides with the surface
21 of the hard disk 20. Thus, as the rotation of the hard disk 20 stops and the lift disappears, the
22 magnetic head 50 safely lands on the parking area 21 and the recording area 22 is not contacted by
23 magnetic head 50.

1 [0010] If the magnetic head 50, placed in the parking area 21, was pushed toward the recording
2 area 22 by an external impact, the magnetic head 50 in contact with the surface of hard disk 20 could
3 then come into contact with the recording area 22. Accordingly, a defect such as a scratch can be
4 generated in the recording area 22. Thus, to prevent the above defect, it is desired the actuator 30
5 be locked when the magnetic head is in the parking area 21 by adopting a latch device so that the
6 actuator 30 does not pivot in response to an external impact.

7 [0011] However, since the actuator 30 is locked by an electromagnetic force applied between the
8 iron piece 61 and the magnetic member 43, if an impact greater than the electromagnetic force is
9 applied, the actuator 30 is unlocked and the magnetic head 50 in contact with the surface of hard disk
10 20 could then come into contact with the recording area 22.

11 [0012] Also, to pivot the actuator 30, being in a locking state, the electromagnetic force generated
12 between the mobile coil 35 and the magnet 41, which exceeds the coupling force of the magnetic
13 force between the iron piece 61 and the magnetic member 43, is applied to move the actuator 30 to
14 unlock it. Thus, the force to magnetically engage the iron piece 61 and the magnetic member 43 is
15 limited.

16 [0013] That is, when the force to magnetically engage the iron piece 61 and the magnetic member
17 43 is too small, the actuator 30 is easily unlocked by a small external impact. When the force to
18 magnetically engage the iron piece 61 and the magnetic member 43 is too large, the actuator 30 is
19 not easily unlocked even when the maximum electromagnetic force is generated to pivot the actuator
20 30. In such a structure, when the actuator 30 is unlocked by overcoming the magnetic engaging
21 force between the iron piece 61 and the magnetic member 43, the actuator 30 springs back abruptly
22 due to inertia and the coupling protrusion 36 may strongly collide with a stopper 42. The use of a
23 stopper is described in the 6,088,193 patent. If the actuator 30 collides with the stopper 42, head slap

1 may be generated due to the impact. To reduce the head slap, current needs to be applied to the
2 mobile coil 35 to generate a braking force to the actuator 30 at the same time the actuator 30 is
3 unlocked. However, it is difficult to configure a control system to timely applying the needed
4 current to the mobile coil 35 to properly generate the braking force. Also, the damper 60 may be
5 damaged since continuous stress is applied to the damper 60 due to repeated actions of locking and
6 unlocking.

7 **[0014]** To reduce the above described head slapping, the above system could be modified to
8 reposition the stopper as in U.S. Patent No. 6,134,086 to Myung-Il Kim and entitled *Actuator Crash*
9 *Stopper For A Hard Disk Drive*. However, there remains a problem in determining the proper
10 amount of magnetic force between the iron piece 61 and magnet 43 which should be applied to
11 prevent the actuator 30 from being unlocked by an externally applied force greater than the magnetic
12 force between the iron piece 61 and magnet 43.

13 **[0015]** Actuator latch devices, incorporated by reference herein, having improved structure for
14 maintaining a locking state of an actuator and for performing electromechanical locking and
15 unlocking actions are described in U.S. Patent No. 5,381,20 to Chunjer C. Cheng entitled *Bi-Stable*
16 *Mechanical Latch For Disk Drive Actuator*; U.S. Patent No. 5,671,104 to Kohji Takashi et al.
17 entitled *System And Method For Locking A Disk Actuator In Vertical And Horizontal Directions*;
18 U.S. Patent No. 5,812,345 to Aaron S. MacPherson et al. entitled *Monostable Active Latch For A*
19 *Disk Drive Actuator*; U.S. Patent No. 5,623,384 to Thomas A. Hickox et al. entitled *Landing Zone*
20 *Inertial Latch*; U.S. Patent No. 5,612,842 to Thomas A. Hickox et al. entitled *Landing Zone Inertial*
21 *Latch*; and U.S. Patent No. 5,483,399 to Woo-Cheol Jeong et al. entitled *Self-Latching Restraint For*
22 *An Actuator Of A Disk Drive*.

SUMMARY OF THE INVENTION

[0016] To solve the above-described problems, it is an object of the present invention to provide an actuator latch device of a hard disk drive having improved structure which can firmly maintain a locking state of an actuator and simultaneously perform locking and unlocking actions smoothly.

[0017] To achieve the above object, there is provided an actuator latch device of a hard disk drive for locking an actuator to prevent its movement when a magnetic head installed at one end of the actuator is positioned in a parking area, the actuator latch device comprising a locking protrusion provided on a second end of the actuator, a stopping guard having a pair of oppositely disposed hooking portions for restricting a pivot range of the locking protrusion, a latch lever rotatably installed for locking the actuator, which rotates in one direction to have the magnetic head positioned in the parking area, to prevent its movement back in the opposite direction, the latching lever being rotated about a pivot point to move one end of the latch lever having an interference portion to trap the locking protrusion between the interference portion and one of the hooking portions, and a latch lever driving means formed on a second end of the latch lever for driving the latch lever between a latched or locked position and an unlatched or unlocked position.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] A more complete appreciation of the present invention, and many of the attendant advantages thereof, will become readily apparent as the same becomes better understood by reference to the following detailed description when considered in conjunction with the accompanying drawings in which like reference symbols indicate the same or similar components, wherein:

[0019] FIG. 1 is a plan view showing a hard disk drive adopting an exemplary actuator latch

device;

[0020] FIG. 2 is a plan view showing a hard disk drive adopting an actuator latch device, according to the present invention;

[0021] FIG. 3 is a perspective view showing the actuator latch device shown in FIG. 2, according to the present invention;

[0022] FIGS. 4A and 4C are views for explaining a locking step of the actuator latch device shown in FIG. 2, according to the present invention; and

[0023] FIGS. 5A and 5B are views for explaining an unlocking step of the actuator latch device shown in FIG. 2, according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0024] Referring to FIGS. 2 and 3, a magnetic head transfer mechanism includes an actuator 300 installed on a base 100 where a hard disk 200 is installed, to be capable of pivoting and having a magnetic head 500 installed at one side thereof, and a voice coil motor for pivoting the actuator 300 so that the magnetic head 500 can move across a parking area 210 and a recording/reproducing area 220 formed on the hard disk 200.

[0025] Here, the actuator 300 includes a suspension portion 310 for supporting the magnetic head 500, an arm 320 rotatably coupled to a pivot shaft 340 provided on the base 100, and a bobbin portion 330 around which a mobile coil 350 of the voice coil motor is wound.

[0026] The voice coil motor includes the mobile coil 350, and a magnet section 410 installed on a yoke section 400 installed on the base 100 for generating a magnetic field. The yoke section 400 and magnet section 410 comprise a pair of the yokes 400a and 400b and magnets 410a and 410b respectively arranged above and below the bobbin 330 of actuator 300, as shown in FIG. 3. Thus,

1 magnetic fields in the vertical direction are formed by the upper and lower magnets 410a and 410b
2 between the upper and lower yokes 400a and 400b.

3 [0027] A latching or locking mechanism, for locking the actuator 300 when the magnetic head 500
4 is disposed in the parking area 210 of the hard disk 200, includes a locking protrusion 331
5 rearwardly extending from the bobbin 330, a stopping guard 610 having a pair of oppositely
6 disposed (left and right side) hooking portions 611 for limiting a scope of travel of the locking
7 protrusion 331 thereby limiting the pivoting action of actuator 300 around pivot shaft 340, a latch
8 lever 620 installed to be capable of rotating around a rotation shaft 623 provided on the stopping
9 guard 610, an interference portion 621 and a coil 640 disposed on opposite ends of the latch lever
10 620, and a power supply portion 630 as a means for rotating the latch lever 620.

11 [0028] The power supply portion 630 supplies current to the coil 640 on one end 622 of latch lever
12 620 by selectively changing the direction of the current. Then, a magnetic field is formed at the one
13 end 622 of latch lever 620 according to the direction of current and the one end 622 of the latch lever
14 620 becomes an N or S pole. The polarity of one end 622 interacts with the magnetic field formed
15 between the upper and lower yokes 400a and 400b and acts as a driving force to rotate the latch lever
16 620. Each of the upper and lower yokes 400a and 400b include a corresponding coupling portion
17 401 rearwardly protrudes therefrom so that the one end 622 of the latch lever 620 magnetically
18 adheres to the coupling portion 401 having an opposite polarity from the polarity of the one end 622.

19 [0029] The interference portion 621 provided on the other end portion of latch lever 620 locks the
20 actuator 300 in the state in which the magnetic head 500 is disposed in the parking area 210 so that
21 the locking protrusion 331 is confined to a space between the interference portion 621 and the right
22 side hooking portion 611 of the stopping guard 610.

23 [0030] The interference portion 621 includes a first portion 621a attached to the latch lever 620

1 and a second portion 621b, in the form of an inclined step (see FIG. 4C) having an inclined surface
2 621b', protruding from the first portion 621a and toward the bobbin 330.

3 **[0031]** In the above structure, when the rotation of the hard disk 200 stops, for example, when the
4 power is turned off, an electromagnetic force is generated by the interaction between the current
5 flowing through the mobile coil 350 and the magnetic field generated by the magnet section 410.
6 As shown in FIG. 4A, the actuator 300 pivots in a direction indicated by an arrow C so that the
7 magnetic head 500 enters the parking area 210. Here, the power supply portion 630 supplies current
8 to the coil 640 in one direction to form a polarity to the latch lever 620 so that the latch lever 620
9 is rotated in a direction indicated by an arrow A as shown in FIG. 4B by the interaction between the
10 upper and lower yokes 400a and 400b. Accordingly, the one end portion 622 of the latch lever 620
11 magnetically adheres to the coupling portion 401 of the lower yoke 400b while the interference
12 portion 621 on the other end portion of the latch lever 620 is moved to a position to interfere with
13 the movement of locking protrusion 331. However, when the locking protrusion 331 is moved
14 toward a parking position, as shown in FIG. 4C, the locking protrusion 331 moves toward right side
15 hooking portion 611 and along the inclined surface 621b' of second portion 621b. Here, the latch
16 lever 620 is slightly pushed in the direction B while the locking protrusion 331 moves over the
17 inclined surface 621b'.

18 **[0032]** Then, the locking protrusion 331 stops after coming into contact with the right side
19 hooking portion 611 of the stopping guard 610. Should the locking protrusion 331 spring back in
20 the direction opposite the C direction, it is stopped by the interference portion 621 of the latch lever
21 620, because after the locking protrusion 331 passes second portion 621b, the latch lever 620 traps
22 the locking protrusion 331 between right side hooking portion 611 and interference portion 621 by
23 being rotated in the direction A by magnetic attraction between coupling portion 401 of the lower

1 yoke 400b and one end 622 of latch lever 620. Accordingly, unless the latch lever 620 is unlocked,
2 the locking protrusion 331 maintains a fixed state. Thus, after the magnetic head 500 is positioned
3 on the parking area, the actuator 300 maintains a stable locking state.

4 **[0033]** The reason for supplying current to the coil 640 is to provide a driving force so that the
5 latch lever 620 is rotated in a desired direction by providing a desired polarity thereto. Once the end
6 622 of the latch lever 620 magnetically adheres to the coupling portion 401 of the yoke 400b, if the
7 supply of current is cut off, the coupling state between the magnetic bodies is maintained even
8 against a force caused by an external impact on the hard disk housing. Thus, after locking is
9 completed, cutting the supply of current to the coil 640 to reduce consumption of current is
10 preferable.

11 **[0034]** Next, in order to operate the hard disk 200 again by unlocking the actuator 300, the power
12 supply portion 630 supplies current to the coil 640 in the direction opposite to the direction for
13 locking. Then, polarity is formed on end 622 of the latch lever 620 to be opposite to that in the
14 locking state. As shown in FIGS. 5A and 5B, the latch lever 620 rotates in the direction **B** by the
15 interaction with the magnetic field formed between the upper and lower yokes 400a and 400b.
16 Accordingly, the interference portion 621 is separated from the position for interfering with the
17 locking protrusion 331 and the locking protrusion 331 becomes free within a range of restriction by
18 the stopping guard 610. Thus, the actuator 300 which is unlocked freely pivots to move the
19 magnetic head 500 in the recording/reproducing area 220 of the hard disk 200. After the unlocking
20 action, the current of the coil 640 is preferably cut off to reduce consumption of current and end 622
21 of latch lever 620 remains magnetically adhered to coupling portion 401 of the yoke 400a.

22 **[0035]** Consequently, the actuator moves very smoothly compared to a latch device according to
23 a conventional latch device since the locking and unlocking actions are performed as the interference

1 portion 621 of the latch lever 620 moves to the position where the movement of the locking
2 protrusion 331 of the actuator 300 is restricted or free. That is, referring back to FIG. 1, when a
3 magnetic coupling between the iron piece 61 and the magnetic member 43 is removed, since the
4 locking protrusion 36 frequently collides with the stopper 42 due to inertia generated to overcome
5 the magnetic attraction between iron piece 61 and magnet 43, the head 500 may be damaged. In
6 contrast, in the present invention, the latch lever 620 need only rotate in response to the magnetic
7 attraction between the coupling portion 401 of yoke 400a and the end 622 of latch lever 620 to
8 unlock the locking protrusion 331. That is, there is no inertia generated to overcome the magnetic
9 attraction between coupling portion 401 of yoke 400b and the end 622 of latch lever 620. Thus, the
10 actuator 300 can move freely so that unlocking is performed smoothly and stably. Thus, no impact
11 is generated due to the unlocking action and a complicated structure for applying a braking force to
12 the actuator 300 concurrently with unlocking to prevent generation of an impact, is not needed.
13 Also, after locking, unless the latch lever 620 rotates to a position for unlocking, a firm locking state
14 can be maintained since the actuator 300 cannot move.

15 [0036] As described above, in the actuator latch device of a hard disk drive according to the
16 present invention, since locking and unlocking is performed by selectively restricting movement of
17 the locking protrusion provided on the actuator, a locking state can be firmly maintained and
18 unlocking is performed smoothly without any impact.